

Patent Landscape Analysis





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EXECUTIVE SUMMARY

Internet of Things (IoT) is possibly the most widely discussed technological concept in today's technology circles. This technology is expected to dramatically change not only how we work but also how we live. The concept of IoT basically means a web of connected devices which can be controlled over a data network. With cost of technology required to control these devices going down and increasing internet connectivity through smartphones, IoT is expected to be an all pervasive technology in the next 10 years.

In this report, we study the technological landscape of this fast growing technology domain from an Intellectual Property (Patents) perspective. We find that the majority of Patenting activity in this domain occurred in technology areas related to Resource Management in a Wireless network. We find that the patent distribution in this domain is very fragmented with the Top patent filer in the field holding around 5% of the total patents. LG holds the largest patent portfolio and, it is closely followed by Ericsson and Qualcomm. The US geography has seen the maximum patent filings and is closely followed by the big Asian markets of Japan, Korea and China.

Using our proprietary patent analytics tool LexScoreTM, we identify Qualcomm as the leader in this technology domain with high patent portfolio quality as well a good patent filing activity. NPEs like Interdigital and ETRI hold substantial patents in their portfolio. With a very fragmented patent holding pattern and a high patent filing activity, we expect to see significant patent licensing activity in this technology domain. Using our Licensing Heat-map framework, we predict significant patent licensing activity in the Wireless Communication Protocol and Device Control Systems technology segments.

In the following paragraph we present our analysis of the Patent Landscape of this technology domain.



INTRODUCTION

The internet of things refers to use of sensors, actuators and communication technology embedded into physical objects that enables such objects to be tracked and controlled over networks like the internet. The use of these devices would involve three main steps: capture of data using sensors, collection of data over the network and decision making based on analysis of data. This decision making can result in improved productivity of current processes as well as enable new types of products and services being offered in multiple application areas.

A McKinsey study¹ estimates the potential economic impact of Internet of Things to be \$2.7 trillion to \$6.2 trillion per year by 2025 with applications in Healthcare, Manufacturing, Power, Urban Infra-Structure, Security, Vehicles and Agriculture. The impact in Healthcare is expected to be between \$1.1 trillion to \$2.5 trillion per year by 2025 and the greatest benefit could come from improved efficiency in treating patients with chronic conditions through efficient use of sensors, like glucose sensors, for remote monitoring.

By efficient use of sensors to track machinery status and real-time updates to reduce downtime, gains in Manufacturing are pegged at \$900 billion and \$2.3 trillion per year by 2025. Additionally sensors can be used to monitor the flow of inventory around factory floors or between different workstations, resulting in improved inventory management.

Demand prediction and better management of resources using embedded technologies in the Power segment can potentially save between \$200 billion to \$500 billion by 2025. Power consumers can use internet of things technologies to power down their high-use systems and appliances during periods of peak demand to avoid peak demand charges.

Urban Infrastructure today faces several challenges which can be better tackled using smart technologies. Traffic and waste management are problems that are better managed scientifically. \$100 billion to \$300 billion is the annual projected gains in this industry by 2025. Currently the cities of Doha, Sao Paulo, and Beijing all use sensors in pipes, pumps, and other water infrastructure to monitor conditions and manage water loss, identifying and repairing leaks or changing pressure as necessary. On average, these cities have managed to reduce leaks by 40 to 50 percent. Smart meters at the consumer end allow real-

1990: A Thing Is Born –the bare beginnings of Internet of Things

John Romkey and Simon Hackett create the world's first connected device (other than a computer): a toaster powered through the Internet.

1999: "Internet of Things": Kevin Ashton coins the term "Internet of things" and establishes MIT's Auto-ID Center, a global research network of academic laboratories focused on RFID and the IoT.

¹ Disruptive technologies: Advances that will transform life, business and the global economy, May 2013, McKinsey Insights and Publications



time monitoring of demand and leak detection by residents and property managers, reducing costs. Dubuque and Indianapolis in the United States, as well as Malta, New Delhi, and Barrie (Ontario), have seen, on average, a 5 to 10 percent reduction in water usage via the use of smart water meters. This can be a step forward in the development of smart infrastructure, smart waste and water handling techniques.

Security is expected to benefit largely from improved surveillance techniques in the form of inexpensive sensors on light poles and sidewalks. Gains of \$100 billion to \$200 billion are expected due to the ability to heavily eliminate the cost of crime. Internet of Things has the potential to add significant value in agricultural sector by raising global yields through 'precision farming' which allows farmers to utilize sensor data. The ability to reduce property damage from vehicle crashes using sensors would also significantly cut unnecessary expenses by close to \$50 billion.

The vision of the internet of things is that individual objects of everyday life such as cars, roadways, pacemakers, wirelessly connected pill-shaped cameras in digestive tracks, smart billboards which adjust to the passersby, refrigerators, or even cattle can be equipped with sensors that can track useful information about these objects. Furthermore, if the objects are uniquely addressable and connected to the internet, then information from these objects can flow through the same protocol that connects our computers to the internet. Thus, such objects can help understand complexity in systems and allow automated responses that don't require human intervention.

As market players compete to realize the huge economic potential offered by the Internet of Things, we have seen a flurry of M&A activity in this domain. Google's \$3 billion plus acquisition of Nest, and Qualcomm's \$2.5 billion acquisition of CSR are the biggest transactions in this domain yet. Further Samsung, Dell and Intel among others recently announced a partnership to develop standards in this field quite akin to the telecom standards such as 3G and 4G. Existing IoT players like KT Corporation and SomFy will continue to feel the heat from tech giants vying to enter this fast growing market.

In such a financially lucrative and fast evolving market safeguarding a company's interest using Intellectual property is an important strategy for market players. Assessing the IP landscape is therefore an important exercise for current market players as well as companies who are looking to enter this market. In the following paragraphs we analyze the patent landscape of Internet of Things. First, a technological taxonomy is presented, followed by a discussion on the important players in this market. The report concludes by highlighting future licensing areas in the field of Internet of Things.

Google has spent **\$5.5 billion** in acquiring IoT companies like Nest, Boston Dynamics, Waze and Dropcam.

Samsung has collaborated with Intel, Dell, Atmel, Broadcom, Wind River, NEST, ARM Holdings, Freescale Semiconductor, Silicon Labs, LG, SK Telecom and KT Corp. to develop the standards of IoT.



TAXONOMY

Internet of Things (IoT) is a concept that interconnects uniquely identifiable embedded computing devices, expected to offer Human-To-Machine (H2M) communication replacing the existing model of Machine-To-Machine communication. The convergence of multiple technologies, ranging from embedded systems to micro-electromechanical systems, and from wireless communication to internet, has brought an upsurge in the development of Internet of Things (IoT) technologies. For the purpose of this study, a set of patents that are integral to IoT are extracted based on comprehensive research. The patent portfolio has been divided into three broad categories - Networking, Computing and Infrastructure. A large number of patents have been filed covering important application areas hence a fourth category covering those technologies was also introduced. Patents in each of the broad categories (henceforth referred to as Level 1 category) are further categorized into subcategories (henceforth referred to as Level 2 category) of Level 1 category. Each of the Level 2 categories roughly covers the application areas of each Level 1 category. We further divide each of the Level 2 categories in to Level 3 categories; each Level 3 category covers functional aspects of a Level 2 category. Please note that as a patent may discuss functionalities covered under multiple Level 3 categories so a patent may be categorized in to multiple Level 3 category.

Please refer to Table 3 in the Appendix for detailed definitions of the various Level 3 categories used in this report.

In the Networking level 1 category, the following three categories are of interest: Resource Management, Communication Protocols, and Topology Management; with 2669 patents filed in Resource Management (Wired & Wireless), 2212 in Communication Protocols (Wired & Wireless) and 1676 in Topology Management (Wired & Wireless). Resource Management (Wired & Wireless) has seen a lot of patenting activity in the last 5 years with 2201 patents being filed in the last 5 years.

In the Computing level 2 category, Information Retrieval, Image Processing, and Data Security are the main focus areas; with 984, 671 and 628 patents filed respectively. Information Retrieval has seen significant activity with 377 patent filings in the last 5 years.

Apple launched HomeKit in partnership with: Philips, OSRAM, iHome, Haier, SkyBell, August Smart Lock, Kwikset Smart Key, Broadcom, Netatmo, Honeywell.

The term 'Internet of Things' was added to the 2011 annual Gartner Hype Cycle that tracks technology lifecycles from "technology trigger" to "plateau of productivity" and has hit the Hype Cycle's "Peak of Inflated Expectations" in 2014.



Table 1: Taxonomy

Level 1	Level 2	Level 3	Patents
		Communication Protocol	1006
Networking	Wired	Resouce Management	475
	wired	Multiplexing Methods	167
		Topology Management	716
		Resouce Management	2194
		Topology Management	960
	Wireless	Communication Protocols	1206
		Multiplexing Methods	292
		Radio Frequency Protocols	303
		Baseband Processing	167
		Routing Algorithms	83
	Algorithm	Image Processsing	671
		Character Recognition	85
Computing		Error Correction	224
	Encryption	Data Security	628
		Data Encryption	424
	Memory Management	Information Retrieval	984
	Control Systems		980
Infractructura	Power Management		236
innastructure	Hardwara	Circuits	893
	Haruware	Sensors	277
		Home Automation	176
		Transportation	634
		Home Security	755
	Applications	E-commerce	1088
Miscellaneous Patents		Healthcare	735
		Entertainment	111
		Alarm Systems	193
	Measurement/Testing		175
	Others		247

Control Systems, Circuits, and Sensors form the key focus areas under Infrastructure with 980, 893 and 277 patents filed respectively. Over the last 5 years, 700 patents were filed in the field of Control Systems alone.

In the Miscellaneous category, 1088 patents were filed in E-Commerce, 755 in Home Security, and 735 in Healthcare. E-Commerce, which covers all the transaction related processes has seen a lot of patenting activity in the last 5 years with 689 patents being filed in the last 5 years. Predicted market capital in IoT by 2020 is **\$7.1** trillion.



The network constitutes the most important part of Internet of Things, and Resource Management being an important part of networking has witnessed the most patenting activity. For the same reason, the most number of patents filed are in Information Retrieval, Control Systems, and E-Commerce domains. There will be 20-50 billion 'things' connected to the internet by 2020.



TOP ASSIGNEES

Figure 1 shows the distribution of patent filings across the top assignees in the field of IoT. LG with 482 patent filings has emerged as the top filer with Ericsson taking the second spot with 404 patent filings. The distribution of patents is very fragmented with the top filer having around 5% of the total patent filings. Such distribution is indicative of the fact that there is a huge scope of cross patent licensing, mergers and acquisitions and collaborations in the field of IoT. It is also observed that amidst big players like LG, Samsung, and Ericsson etc., some NPEs like Interdigital and ETRI also have high patent filings in IoT. The emergence of such NPEs in the list of top players and the fragmented distribution of patent filings indicates that there are high chances of much patent litigation in this domain in future.

The emergence of NPEs like Interdigital & ETRI as top players indicates high chances of licensing activities.







GEOGRAPHICAL COVERAGE

Figure 2 shows the geographical distribution of the patent set in the field of IoT. It can be observed that most patents are filed in the United States. Apart from the US, extensive patent filing is seen in countries like China, South Korea, Canada, Taiwan and Japan indicating high end research and development in the field of IoT in these countries.

According to PwC's 6th Annual Digital IQ survey of nearly 1,500 business and technology executives, Asia is the biggest market for IoT in the world today and major investments in the field have also been made in Asia. This high market growth rate and high number of patent filings in Asia can be attributed to the location of top players like LG Electronics, Samsung etc. in Korea.

Besides Korea, LG Electronics has filed most of its patents related to IoT in the US. Ericsson, which is the second largest patent filer has its top filings in the US and European countries.

China is planning to invest nearly **\$750 million** in the IoT industry by 2015. It has set up the Chengdu Internet of Things Technology Institute in Sichuan Province, which is developing a "healthcare capsule."



Figure 2: Geographical coverage of the patents filed in IoT

COMPETITIVE POSITIONING

Figure 3 depicts the competitive positioning of the top 16 assignees in IoT across various parameters.

Grant to Application ratio depicts the split of each Assignee's portfolio into granted patents and applications. In the current scenario, Somfy leads the way with majority of its portfolio featuring granted patents. LG, which started its patent filing activity relatively late, occupies the bottom spot in this list.

Claim broadness score represents the extent to which a portfolio covers various aspects of a technology, i.e. it assigns a score to the patent portfolio indicating the scope of patents held by an assignee. Interdigital, a Non-Practicing Entity (NPE), holds the patent portfolio having the broadest claims. Microsoft portfolio, with low claim broadness, features at the bottom.

Citations Score emphasizes the average number of forward citations for a particular portfolio. A higher Citation score signifies that the patents held by an assignee are widely cited in the industry and R&D activity in the Industry is in similar domains. Microsoft and Interdigital occupying the top two spots, hold portfolios with large forward citations. KT Corporation, on the other hand, is placed at the bottom of the list with lowest number of forward citations.

The Geo score parameter describes a portfolio's coverage across major markets. A high geo score depicts high patent activity across key markets by the assignee. Qualcomm, with its portfolio covering majority of the key markets, features at the top while NEC with its poor geographical coverage, sits at the bottom.

Tech Score describes a portfolio's coverage across multiple technology domains. A high tech score implies coverage of large number of technology domains by the portfolio of an assignee. Interdigital scores high on this parameter whereas KT Corporation scores lowest on this parameter. The number of things connected to the Internet first exceeded the number of people on earth in 2008.

Available Space: With IPv6, the Internet will be capable of having 100 Web addresses for every atom on the earth's surface, paving the way for the Internet of things.





Figure 3: Competitive positioning of Top Assignees



LexScoreTM

We use LexInnova's proprietary LexScore[™] framework to identify the leaders from the intellectual property perspective in the IoT domain. Figure 4 below, represents the competitive positioning of top 15 assignees in the field of internet of things. In the framework, various companies are compared on the basis of their quality score, derived on the basis of parameters discussed in the previous section and filing score (representing the number of patents filed). Owing to its good patent quality and filing activity, only Qualcomm features in the Leadership zone (Green portion of the chart below), positioning itself as a potential market leader. With majority of the filings in recent years, Qualcomm could take a vertical leap in terms of granted patents, thereby improving its portfolio quality and solidifying its position in the IoT space. LG leads the list with the overall score but fails to make it to the green zone owing to its low patent quality score. LG's current position is explained by the fact that majority of its applications have been filed in recent years and in the coming years, an increased number of granted patents can improve its patent portfolio quality and it can possibly make a vertical shift and strengthen its market presence.

Microsoft invested in ten IoT startups: Chai Energy, Heatworks Heatworks, Neura, Novi Security, Reemo, Plum, Red Balloon Security, Scanalytics, Sentri's, Wallflowr.



Figure 4: LexScore[™]

The blue zone, visionaries, comprises players which have a good patent portfolio in terms of quality but miss out on the filing front. Companies like Interdigital, with high patent quality and a moderate filing activity over the past



decade. Other potential players who can move in to Leadership zone are Microsoft, Nokia and Somfy, these players can move into Leadership zone by increasing their filing activity.

The red zone, or 'slowcoaches', captures companies which have missed out on both fronts and should prioritize their R&D on the development of quality portfolio as well as increase their filing activity. With companies like Cisco and Samsung, focusing more on collaborative development in IoT, the coming years can witness a more competitive IoT space. Also NEC, owing to its low number of granted patents, poor geographic filing, with majority of the filing activity in the recent years, features at the bottom of the market presence. **Committed Stake:** Three out of four companies are currently exploring the Internet of things internally, and 68% are allocating IT budget to it.



LICENSING HEAT MAP

We use a Licensing Heat-map framework to identify technology sub-domains in the field of IoT where licensing activity is expected to be higher. The size of the box of the domains (Level 3 categories) indicates the number of patents filed in this domain, which in a way represents the relative importance of the technology sub-domain whereas the color here represents the chances of future licensing activity in this domain. We study the patent holding pattern in the respective technology sub-domain to correlate it with future licensing activity.

The color red (and shades thereof) signifies a high chance of licensing activity in a certain technology sub-domain whereas the color green (and shades thereof) represents a low chance of licensing activity in the technology sub-domain.

Cisco invested \$1 billion in companies like: EVRYTHNG, Ayla Networks, Control4, iControl, Alchemist Accelerator, Insieme and JouleX.

The figure 5 below shows the analysis of the top 10 technology sub-domains in terms of number of patents filed.



Figure 5: Licensing Heat Map

The patents in the field of Wireless Communication Protocols are distributed among a large number of companies. This domain has seen large number of litigations in the past, given the current patent holding pattern in this domain; high licensing activity can be anticipated in future. Control Systems, which is an important component of majority of the appliances found in our homes has a moderate number of patents but a large number of patent holders. With a Apple announced 'HealthKit' and 'HomeKit', two health and home automation developments. The firm's iBeacon advances context and geolocation services.



fragmented patent holding pattern, future licensing and cross-licensing activities are expected to increase in this technology sub-domain.

Several large corporations like Ericsson Inc. and LG Electronics have consolidated the patents of wireless resource management which hints at lower patent licensing activities in this domain LG and Google have a patent licensing deal effective till 2023. These patents describe technologies including dataprocessing, wireless and mobile security patents for various connected devices such as wearables, tablets and for the Internet of Things.



TECHNOLOGY EVOLUTION

The Technology Evolution framework is used to study evolution of a technology. This is depicted by plotting the number of patents against the number of patent filers across filing years; each year (in Figure 6 below) is represented by a point on the graph plane. The first point represents the year 2003 which had only 219 patents with 166 patent filers. Till the year 2009 the number of patent filings in this domain saw a slow but constant rise, with 427 patents being filed by 228 patent filers in 2009. These figures saw a steep rise in the year 2010 where the number of patents filed rose to 1036, with 485 patent filers being involved in these filings. The patent filings continued to increase at a rapid rate with 2222 and 2542 patents being filed in the years 2011 and 2012 respectively. These numbers depicts that there could be a lot of market players in the loT space in the future owing to greater advancements in the domain.

In 2010, Google kicked off the selfdriving vehicle project, a major milestone in the future development of the connected car.



Figure 6: Technology Evolution



APPENDIX

Assignee/Parameter	Tech Score	Claim Broadness	Citations Score	Geo Score	G/A	Quality Score	Filing Score	Overall Score
LG	5.69	7.53	0.85	3.56	0.25	3.31	9.64	3.19
Qualcomm	7.00	8.74	0.86	6.93	0.66	4.23	6.02	2.55
Ericsson	6.03	5.11	0.86	2.31	0.43	2.80	8.08	2.27
Interdigital	9.16	9.05	9.48	4.95	1.25	7.23	2.64	1.91
Nokia	7.63	8.60	3.25	5.71	0.45	4.88	3.16	1.54
IBM	8.41	4.63	3.95	4.10	3.07	4.82	2.94	1.42
Somfy	5.03	4.92	0.83	2.84	9.22	4.37	3.00	1.31
Samsung	7.62	8.47	0.72	4.26	0.51	3.96	2.74	1.09
Alcatel	7.31	5.52	2.92	5.81	0.60	4.14	2.28	0.94
KT Corporation	3.68	8.16	0.20	2.50	0.38	2.75	3.20	0.88
Microsoft	7.62	3.84	9.51	4.43	1.63	5.91	1.42	0.84
Cisco	7.17	8.16	1.31	3.58	0.77	3.97	1.70	0.68
ZTE	7.39	8.56	0.94	4.13	0.37	3.96	1.66	0.66
ETRI	8.63	8.63	0.42	4.33	0.41	4.09	1.42	0.58
Sony	5.63	6.97	1.50	3.87	0.85	3.53	1.58	0.56
NEC	4.81	6.07	0.47	2.24	0.63	2.66	1.50	0.40

Table 2: Quality Matrix



Table 3: Definitions of Level 3 technology heads in Taxonomy

Level 3 Category	Definition
Communication	A set of rules governing the exchange of information between communicating
protocol	devices.
Resource	The techniques involved in the allocation of resources, such as memory, processing
Management	units, etc. to various operations occurring in a system.
Multiplexing	The techniques to combine multiple signals into a single signal over a shared
Methods	medium.
Topology	The way in which the constituting components are connected or arranged in a
Management	network.
Radio Frequency	The set of rules that control the exchange of information between communicating
Protocols	devices which are utilizing radio frequency signals to achieve the exchange of
	information.
Baseband	The management of radio functions (functions that require an antenna).
processing	
Routing algorithm	The procedure to divide the instructions among the plurality of memory and
	processing units.
Image processing	The procedures for performing various operations on image and graphical content.
Character	The techniques involved in the conversion of images, typewritten or printed
recognition	information to machine-encoded text.
Error Correction	Incorporating changes in information before transmission such that any
	error/distortion can be prevented at a later stage.
Data Security	The techniques that are utilized to prevent any unauthorized access to the
	information.
Data Encryption	The techniques which are utilized to encode the information beforehand to resolve
	data error and security issues.
Information	The techniques which are usually utilized for restoring the information from a
Retrieval	particular storage location.
Control System	A set of devices that manages or regulates the behavior of other devices.
Power	The techniques that manage the power consumption of various devices in the
Management	network.



Circuit	It is a mesh of electronic components to achieve a particular operation.
Sensor	It is a device that converts physical changes into electric signals.
Home	Centralized control of various household activities, such as control of temperature,
Automation	lighting, etc.
Transportation	The movement of people, articles and goods from one place to other.
Home Security	Solutions which are particularly designed for surveillance purposes, such as
	security alarm monitoring, and other safety products.
E-Commerce	Trading in goods and services through computer networks (Internet).
HealthCare	Diagnosis, treatment, and prevention of disease, illness, injury, and other physical
	and mental impairments in human beings
Entertainment	Any activity/device that holds the attention and interest of a person.
Alarm Systems	Systems devised to notify the users in case of a security threat or any reminder.
Measurement/	Devices designed to measure a particular parameter, such a temperature,
Testing Devices	pressure, etc. at a particular point.





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